



HAL
open science

Deciphering the effect of propionic acid on anaerobic digestion of sludge: gas production and microbial community structure

Xiaojun Liu, Chloé Soulard, André Pauss, Sabrina Guérin-Rechdaoui, Vincent Rocher, Carlyne Lacroix, Laura André, Thierry Ribeiro, Ariane Bize, C. Roose-Amsaleg

► To cite this version:

Xiaojun Liu, Chloé Soulard, André Pauss, Sabrina Guérin-Rechdaoui, Vincent Rocher, et al.. Deciphering the effect of propionic acid on anaerobic digestion of sludge: gas production and microbial community structure. 18th International Symposium on Microbial Ecology (ISME18), Aug 2022, Lausanne (CH), Switzerland. hal-04482086

HAL Id: hal-04482086

<https://hal.inrae.fr/hal-04482086>

Submitted on 28 Feb 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Deciphering the effect of propionic acid on anaerobic digestion of sludge: gas production and microbial community structure

Xiaojun Liu¹, Chloé Soulard², André Pauss¹, Sabrina Guérin³, Vincent Rocher³, Carlyne Lacroix³, Laura André⁴, Thierry Ribeiro⁴, Ariane Bize⁵, Céline Roose-Amsaleg²

1 Université de Technologie de Compiègne, ESCOM, TIMR (Integrated Transformations of Renewable Matter), Centre de Recherches Royallieu, 60203 Compiègne, France

2 CNRS, ECOBIO-UMR 6553, Université Rennes 1, 35000 Rennes, France

3 SIAAP, Innovation department, 92700 Colombes, France

4 Institut Polytechnique UniLaSalle, Université d'Artois, ULR 7519, 60026 Beauvais, France

5 Université Paris-Saclay, INRAE, PROSE, 92160, Antony, France

Introduction

Many governments of European Union encourage circular bioeconomy. That is why anaerobic digestion (AD) represents one of the most common ways to treat sewage sludge. AD can, at the time, reduce amounts of this waste and valorize its organic matter by producing biogas (mainly CO₂ and CH₄), a renewable energy source. This bioconversion process is catalyzed by highly diverse microbial communities (Figure 1), whose growth and activity are influenced by various biotic and abiotic factors. Among abiotic factors, intermediate compounds of AD, namely, volatile fatty acids, inhibit AD itself. The understanding of this inhibition and the microbial targets remained to be solved.

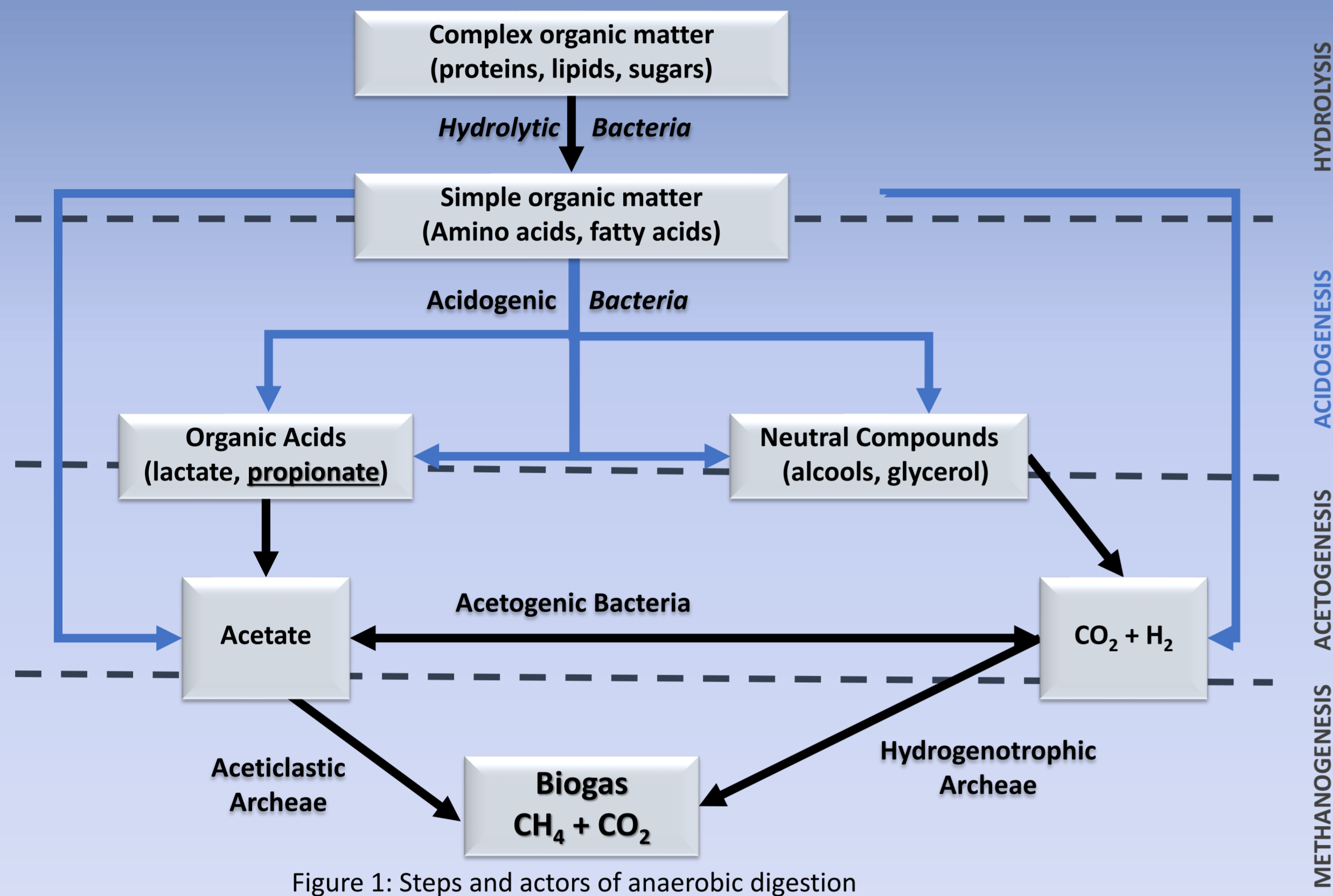


Figure 1: Steps and actors of anaerobic digestion

Aim: Measure the effects of propionic acid on both the gas production and the microbial community structure, in order to identify potential microbial biomarkers of inhibition.

Material and Methods

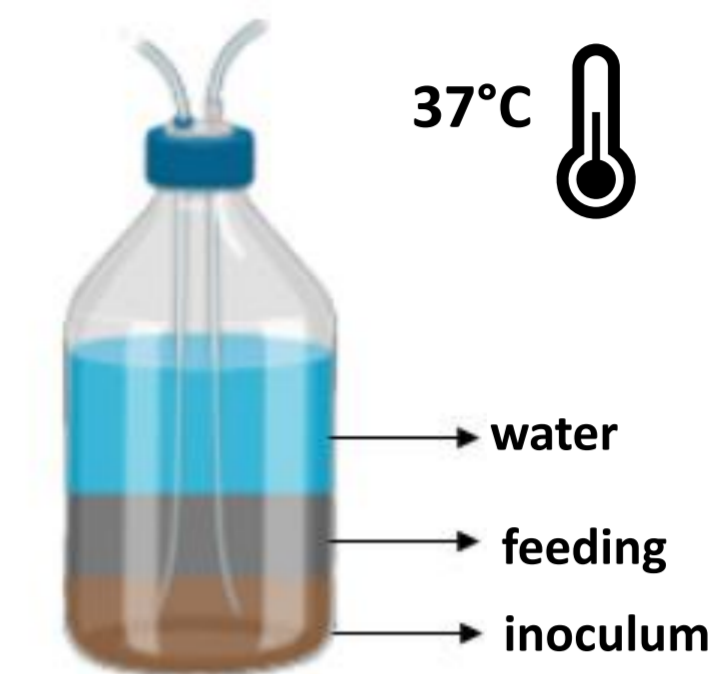
1. Experimental design:

Biochemical methane potential (BMP) test: AMPTS II (Automatic Methane Potential Test System II, Bioprocess, Lund, Sweden)

Amendment at the beginning of the incubation:

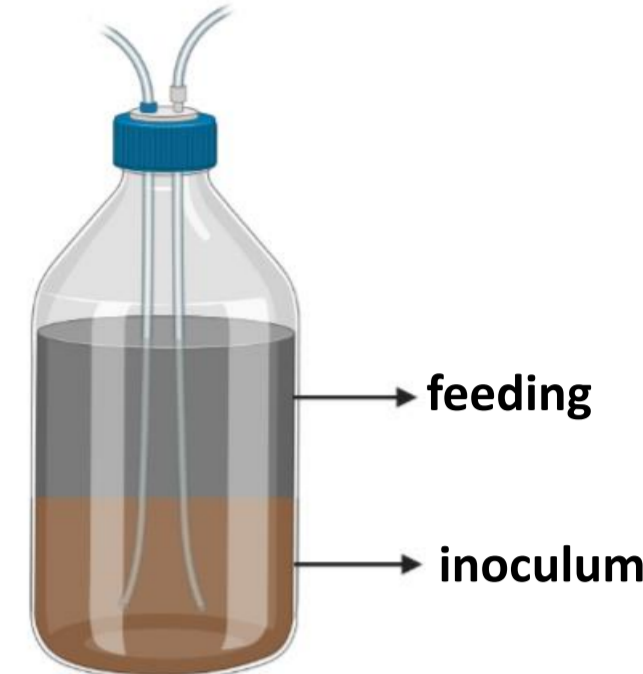
- propionic acid (HPr)
- sodium propionate (NaPr)
- sodium chloride (NaCl)
- or hydrochloric acid (HCl)

1st experiment
kinetics
(x15 pilots)



- Feeding: mixed sewage sludge
- Inoculum: mesophilic digested sewage sludge

2nd experiment
propionate or acidification?
(x30 pilots)



2. Microbial diversity analysis

DNA extracted from digestate (NucleoBond® RNA Soil kit and its DNA co-elution set (Macherey Nagel))

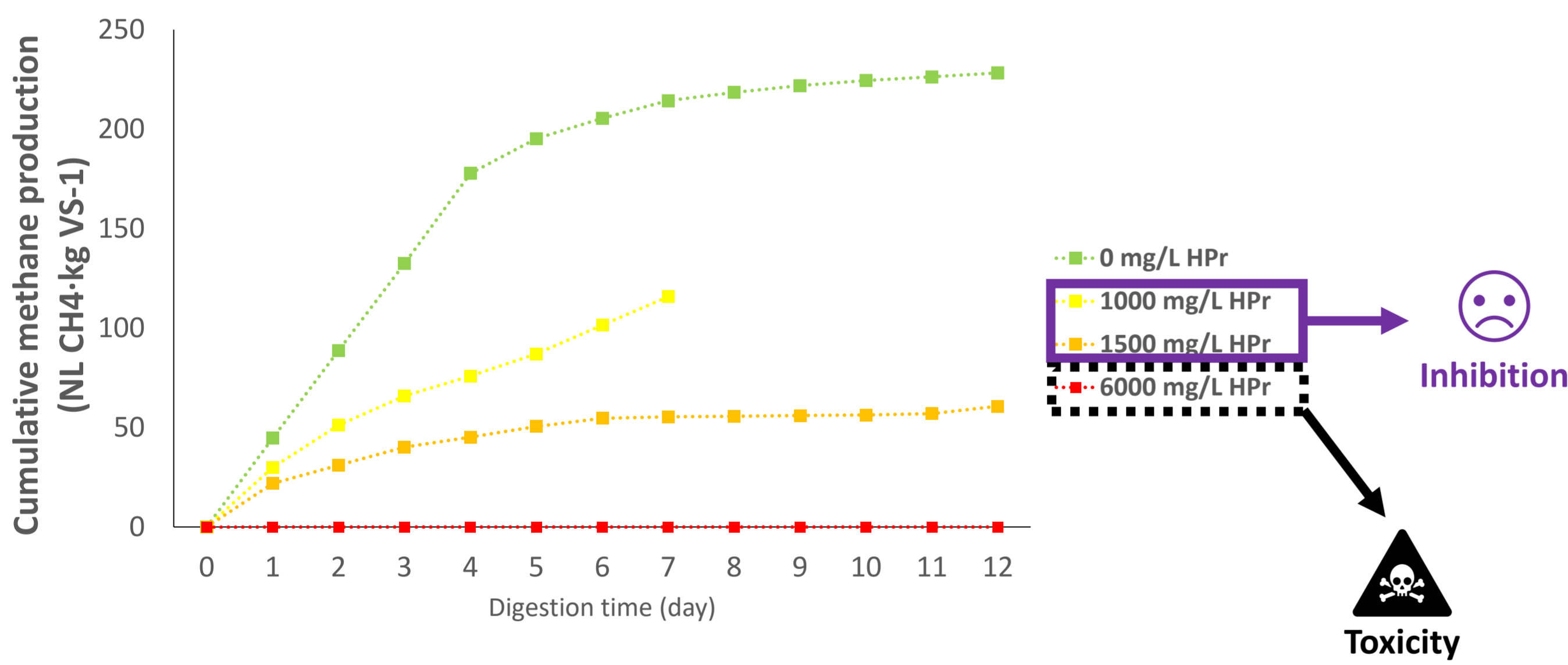
PCR of V4-V5 hypervariable regions of the 16S rRNA gene of bacteria and archaea

Sequencing with Ion torrent PGM technology (Life Technologies, Carlsbad, US)

V4 regions reads analysis with function "Galaxy" on the "INRAE Migale11 bioinformatics platform servers", using the FROGS pipeline (Escudie et al. bioinformatics, 34, 2018)

Results

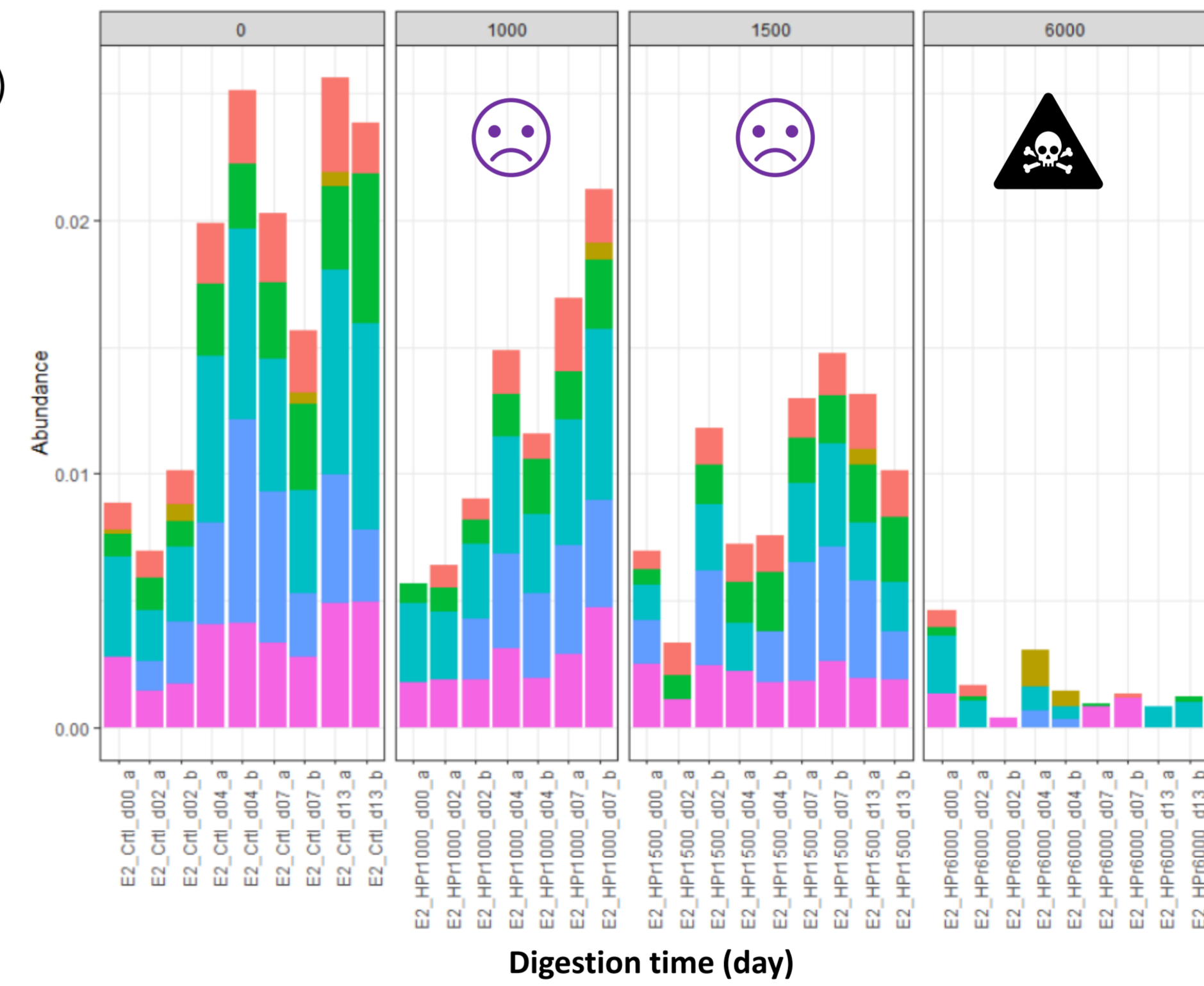
GAS PRODUCTION



MICROBIAL COMMUNITY

1st experiment
kinetics
(x15 pilots)

Archaeal community composition (Top 9 genus) along time

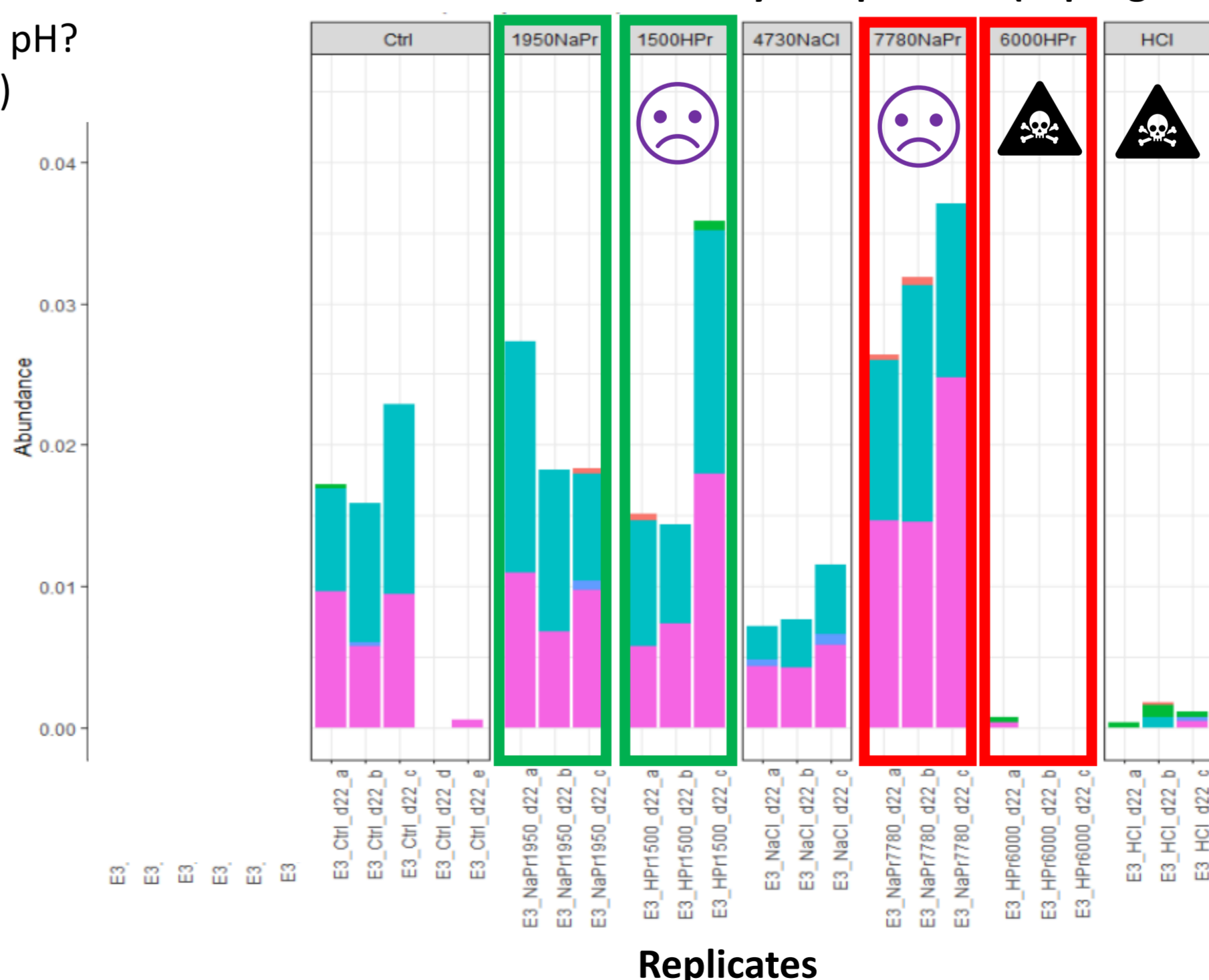


Amendments: propionic acid (HPr, mg/L)
Mean number of reads per sample: 34,000

- Decrease of archeal abundance with [HPr]
- Resilience of the community except at 6,000 mg/L

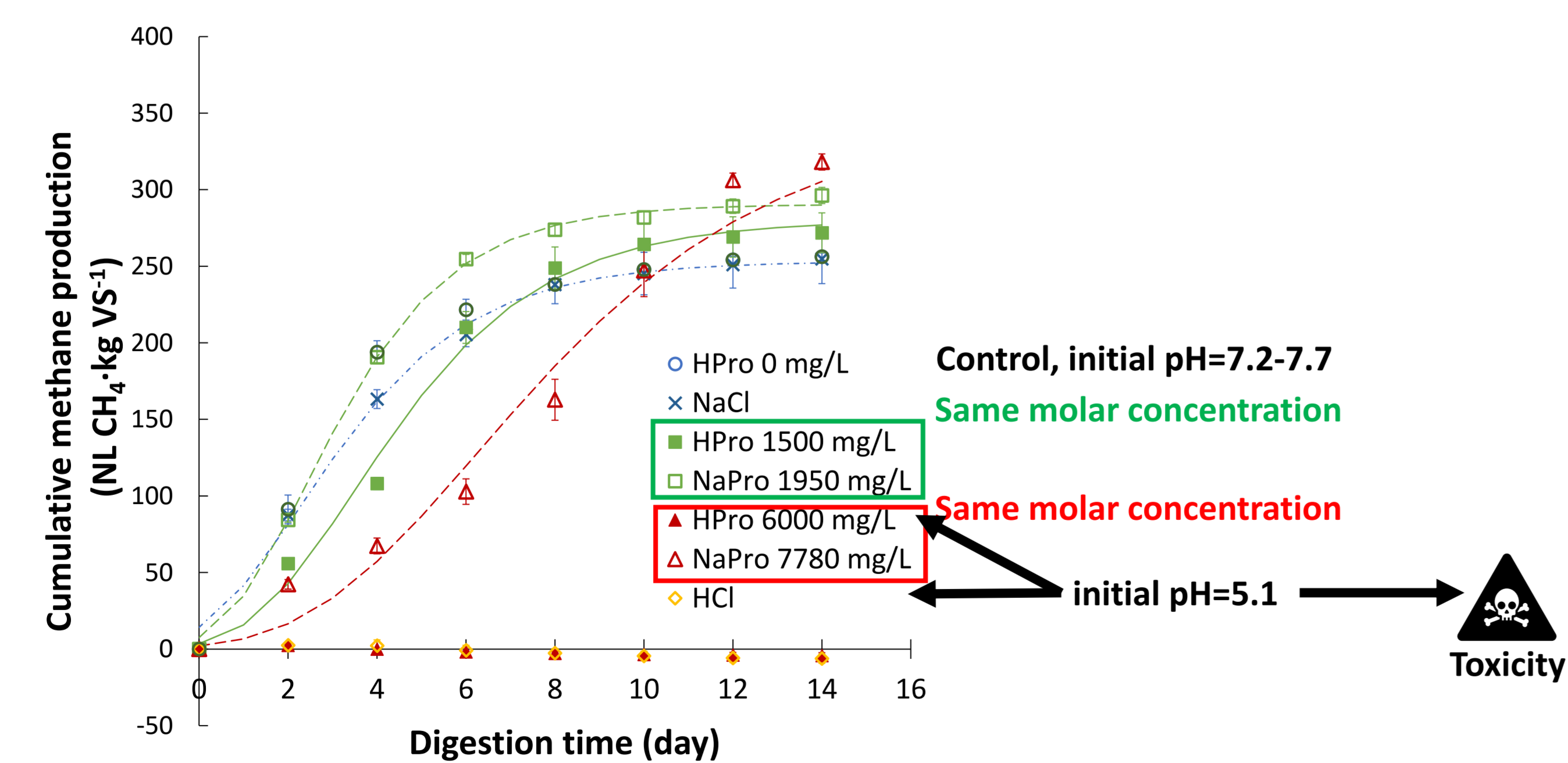
2nd experiment
propionate or pH?
(x30 pilots)

Final archaeal community composition (Top 9 genus)



Amendments
Mean number of reads per sample: 30,700

- Decrease of archeal abundance with acidification and not with [HPr]



Conclusions

The observed stop of CH₄ production was likely due to the pH decrease caused by the dissociation of the propionic acid and entailing the devastation of the archaeal community. When a transient inhibition occurred, different archaea became dominant.